SUMMARY AND CONCLUSIONS

A review of current data showed that there is no justification for redefining the 1986 trust/non-trust ground water line. Ground water flow lines representing spring and fall 1993 conditions showed only minor differences from those used in 1986.

The existing ground water flow model developed by UI and IDWR was used to study the ESPA under various conditions and stresses of development. Although the IDWR/UI ground water model had previously been calibrated, it was recalibrated using more recent and comprehensive data. Recalibration of the IDWR/UI ground water model required multiple trial simulations during which transmissivity and storage coefficient parameters were adjusted to produce a match of historic aquifer discharge and water table elevation values. Final calibration was achieved when simulations using a set of reasonable transmissivities and storage coefficients resulted in an average water table elevation deviation of 3.7 feet and an average difference in aquifer discharge of 250 cfs, as compared to historical values.

Aquifer discharge and water levels on the ESPA have not reached equilibrium and are still responding to historical development. In 1992, over the modeled area of the ESPA approximately 611,000 acres were irrigated from surface water sources, and 818,000 acres were irrigated from ground water sources. By holding net recharge reflecting this level of irrigation constant over many years, a model run was made to simulate equilibrium conditions for a "base study" from which to measure the impact of each "what if" study. At equilibrium, the base study simulation produced an annual average aquifer discharge in the Shelley to Neeley and Kimberly to King Hill reaches of 2665 and 5526 cfs, respectively.

The "what if" model studies compute aquifer discharge values for the Shelley to Neeley reach and the Kimberly to King Hill reach of the Snake River, and the effect on gains to the Henrys Fork by running repeated annual cycles for a single condition. The differences in simulated aquifer discharge from base conditions for each "what if" study are shown in Table 17 after the 25th year and at equilibrium conditions (after 100 years). At 25 years, the change in discharges range from 70 to 90 percent of the equilibrium values. For all of these model runs, changes in net recharge, whether positive or negative, at first have a greater relative impact on aquifer storage, either adding or removing water from the aquifer directly. As equilibrium is approached, changes in storage become smaller while the total change in aquifer discharge to streams and springs becomes greater.

To evaluate the effect of existing irrigation pumping on ESPA discharge and water levels ("no ground water" study), the model was run with all ground water use deleted with the exception of use in the vicinity of the Fort Hall Indian Reservation. At equilibrium, the aquifer discharge for the Shelley to Neeley reach increased by 848 cfs and the Kimberly to King Hill reach increased 620 cfs. It is assumed that the aquifer discharge values after 25 years, the average age of existing ground water development, is representative of the effect of pumping on present aquifer discharge. The aquifer discharge after 25 years for the Kimberly to Neeley reach shows a 675 cfs increase, and the Kimberly to King Hill values increased by 500 cfs. Therefore, 675 cfs of the 848 cfs decrease (80 percent) in the Shelley to Neeley reach has already occurred and 500 cfs of the 620 cfs (80 percent) in the Kimberly to Neeley reach has also occurred.

Table 17. Summary of Effects on ESPA for Upper Snake River Basin Studies

Study	Difference in Computed Discharge from Base Study Shelley to Neeley (cfs)	Difference in Computed Discharge from Base Study Kimberly to King Hill (cfs)	Difference in Gain to Henry's Fork from Base Study Due to Change in HFA Leakage (cfs)	Difference in Computed Discharge from Base Study Shelley to Neeley (cfs)	Difference in Computed Discharge from Base Study Kimberly to King Hill (cfs)	Difference in Gain to Henry's Fork from Base Study Due to Change in HFA Leakage (cfs)
	After 25th Year of Simulation			After 100th Year of Simulation		
No Groundwater	675	499	120	848	620	174
1965-76 Surface Diversions	287	371	48	327	423	62
5% Reduction Surface Diversions	-142	-132	-22	-158	-152	-25
10% Reduction Surface Diversions	-283	-264	-44	-315	-303	-50
15% Reduction Surface Diversions	-424	-396	-64	-472	-455	-75
20% Reduction Surface Diversions	-565	-527	-87	-629	-607	-99
Recharge Scenario A, Option 1	155	146	122	172	167	126
Recharge Scenario A, Option 2	145	144	138	162	162	142
Recharge Scenario B, Option 1	20	18	13	22	21	14
Recharge Scenario B, Option 2	22	12	18	24	14	19

The estimated change from base conditions in Henrys Fork gains due to changes in HFA leakage directly affects natural flow in the study area. To estimate the total change in natural flow in Water District 1, the change in the Henrys Fork gain should be added to the computed change in aquifer discharge in the Shelley to Neeley reach of the Snake River. For example, under the "no ground water" study, the total change in natural flow in Water District 1 after the 25th year would be 675 cfs plus 120 cfs or about 895 cfs. Results of the "no ground water" study are shown graphically in Figure 35.

The water right accounting system used in Water District 1 was used to allocate the impact of flow reductions (decreases in aquifer discharge and thus, natural river flow) among water right holders. The actual accounting for 1993, an average runoff year, and 1992, a dry year, was rerun using the after 25th year impact on natural flow of 895 cfs. The 1993 run resulted in an increase in system reservoir storage of 51,000 acre-feet if ground water withdrawals for irrigation had not occurred. Additionally, the North Side and the Twin Falls Canal Companies would have used 43,000 acre-feet and 53,000 acre-feet less storage, respectively. Other users accounted for another 67,000 acre-feet in storage use reduction. In the 1992 run, the numbers are larger, totaling almost 300,000 acre-feet.

An estimate of the magnitude of the impact on the ESPA from recent reductions in recharge from surface irrigation was made by changing surface irrigation recharge to 1965-1976 levels. Although not directly comparable or additive, results of the model run indicate that surface diversion reduction impact is less than the impact due to ground water pumping and may be on the order of 50 percent of the pumping effect. Relative to ground water pumping, the impact of surface irrigation reduction on natural flows in Water District 1 is less, with less than 50 percent of the reduction occurring above Milner as compared to more than 60 percent in the ground water study. Results of the "1965-1976 diversions" study are shown graphically in Figure 36.

The 5, 10, 15 and 20 percent additional reduction in surface irrigation studies show that further increases in irrigation efficiency could have a major impact on future aquifer discharges. An increase in surface irrigation efficiency of 10 percent could further decrease aquifer discharge on the order of 600 cfs.

No model simulations were made to estimate the effects of increases in irrigated lands over the ESPA. The potential for the development of new irrigation over the ESPA was found by IWRB planning studies to be very limited.

There are twenty basins tributary to the ESPA where studies are necessary to evaluate the impact on the ESPA of development in those tributaries. These studies could be completed at a cost of $546,000 and 91 man-months of effort. There are five basins which have a high priority for study completion based on a greater level of ground water development. Study costs for these five basins are a total of $180,000 and 30 man-months of effort.

Managed recharge has been identified as one option to raise water levels and increase aquifer discharge to the Snake River. IDWR contracted with the University of Idaho, Water Resources Research Institute to identify the best available sites where existing canals could be used in a managed recharge program. While site characteristics suggest there are significant potential recharge sites, the amount of water available establishes the upper limit for recharge capability. A comparison of the diversion capability of existing canals with the availability of surplus natural flow and flood releases show that on the average from 43,000 to 346,000 acre-feet per year could be diverted for recharge, depending on the effect of existing hydropower constraints.

Recharge study results indicate that using existing sites and surplus flows for recharge result in offsetting only about 30 percent of the effects of ground water pumping. However, a seven percent change in surface diversion efficiency results in an equivalent change in recharge. Furthermore, it was shown that very little flexibility exists in achieving specific recharge objectives with existing canals because of the limited capacity of those canals. The effect of using existing facilities to concentrate the recharge in the eastern ESPA (upper system) and the western ESPA (lower system) was analyzed. Studies optimizing upper and lower system recharge produced very little difference in effect on aquifer discharge or water table elevation for both location and timing. Managed recharge capability could be increased significantly by acquisition of storage water and/or the development of new sites not dependent on existing facilities. Results show that hydropower constraints must be addressed for significant recharge to occur. Results of the managed recharge studies are shown graphically in Figure 37.

The simulations run for this study do not model actual sequential annual changes in aquifer discharge or ground water levels, but do provide valuable information needed to evaluate and address a number of issues. Model runs have shown the general magnitude of *average* impact of recent and possible future changes effecting the ESPA. Year to year impacts may be larger or smaller depending on corresponding year to year changes in net recharge. However, any change in net recharge to the aquifer will result in an almost equal change in discharge from the aquifer at equilibrium, although the dampening effect of the aquifer may delay this effect for many years.

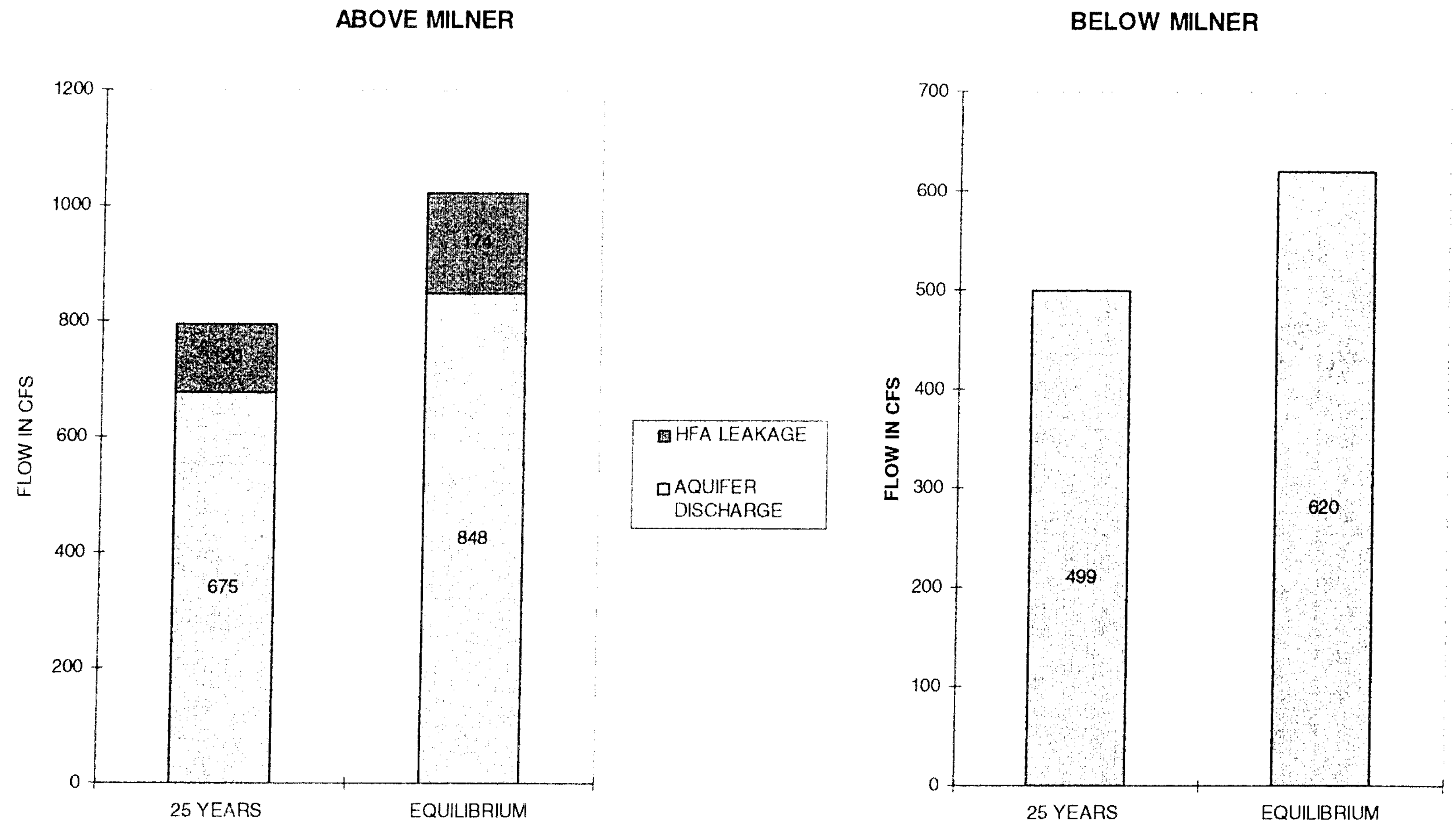

Figure 35. Change in Simulated Reach Gains for "No Ground Water" Study

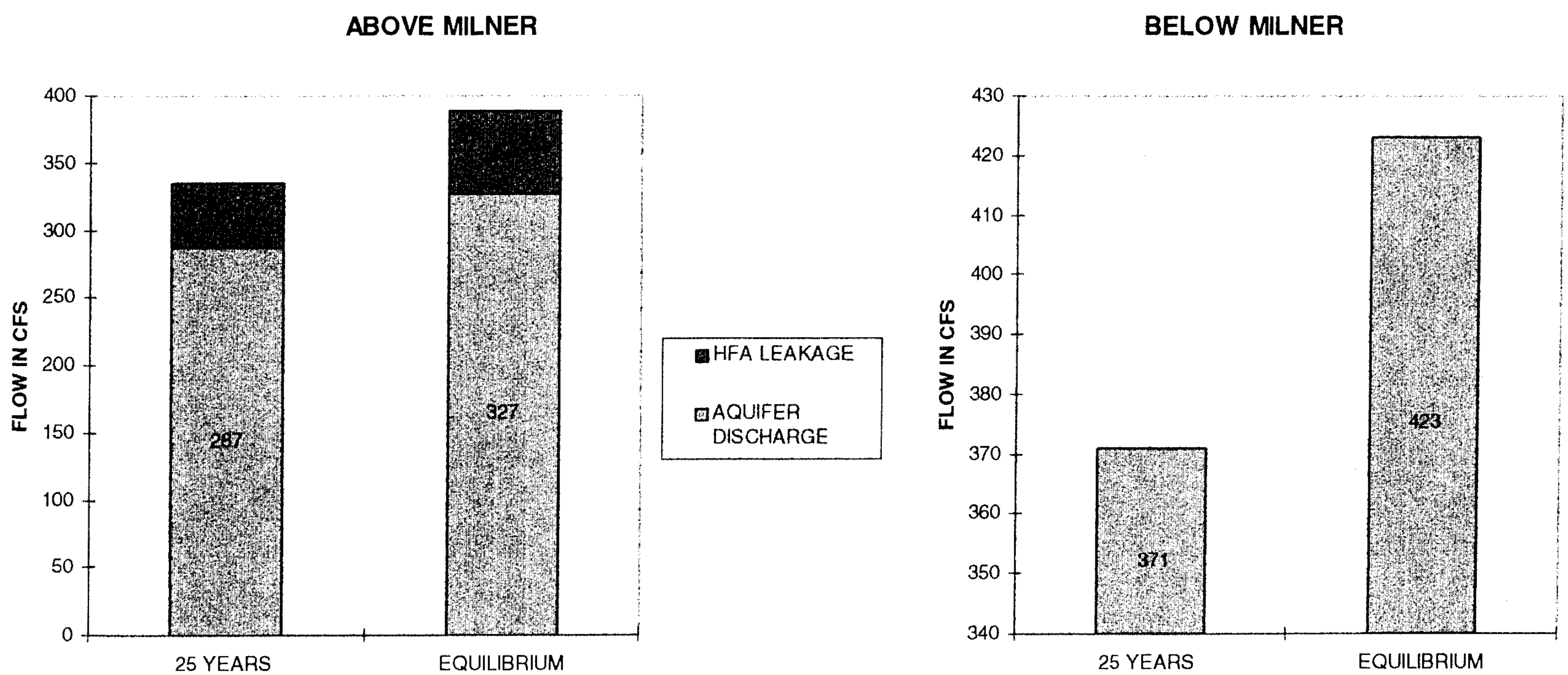

Figure 36. Change in Simulated Reach Gains for "1965-1976 Surface Diversions" Study

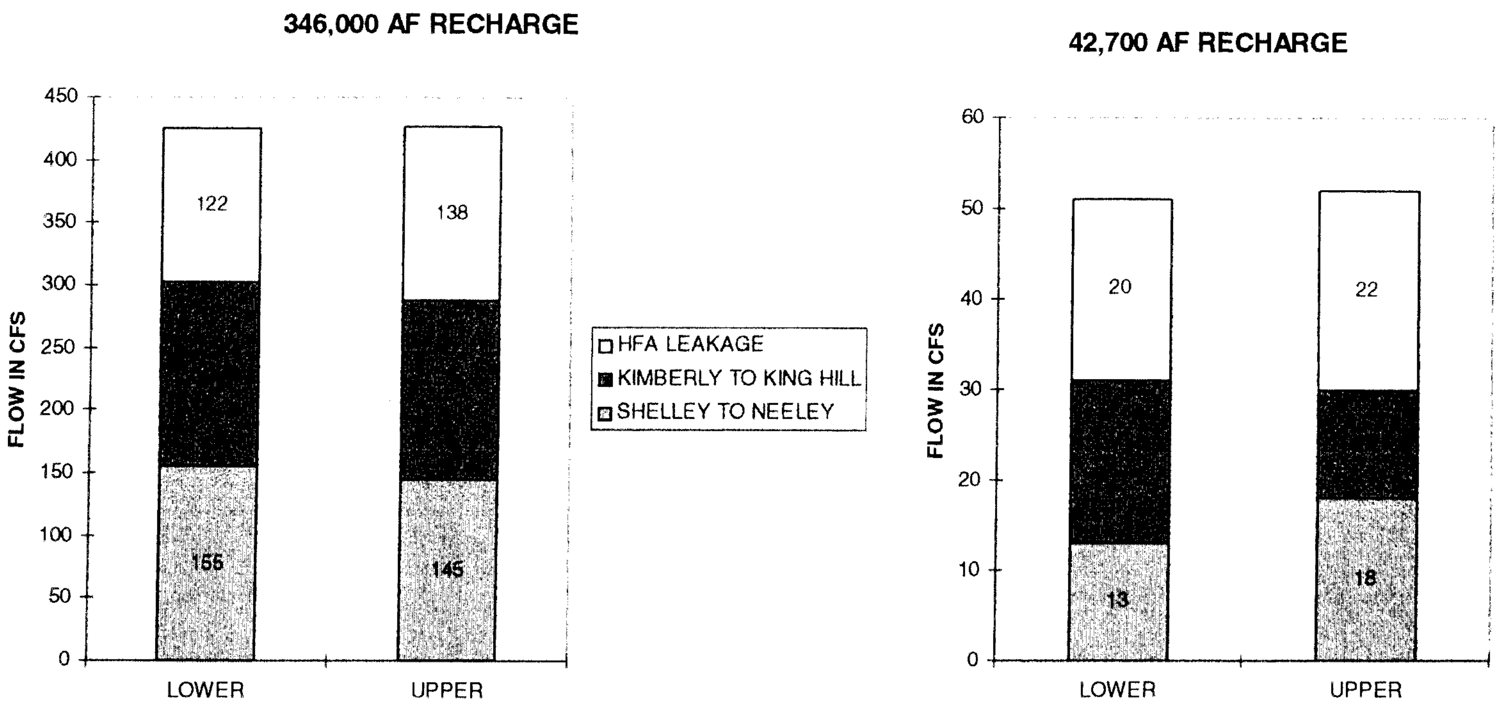

Figure 37. Change in Simulated Reach Gains after 25 Years for Managed Recharge Studies

EPILOGUE

Where We Go From Here - A Framework for Planning Mitigation

by Karl J. Dreher
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This report, which documents the Upper Snake River Basin Study, culminates more than three years of work effort by staff of the Idaho Department of Water Resources, and technical review by the Idaho Technical Committee on Hydrology, to estimate the effects of ground water withdrawals from the Eastern Snake Plain Aquifer and various changes in water use on flows in the Snake River and tributary springs. The data and analytical model that were developed provide the best information available to date on the interrelationships between ground water and surface water in the Upper Snake River Basin.

Some who read this report will claim that the results from this effort can be directly used to quantify impacts and injury to holders of senior surface water rights from ground water diversions under rights having junior priorities. Others will claim that the modeling assumptions, the relatively coarse refinement of the analytical model, and the limited data, render the results unsuitable for quantifying the impacts with sufficient certainty to substantiate any injury. In my judgement, the truth falls between these bounds.

Idaho's constitutional and statutory implementation of the prior appropriation doctrine requires that water rights of senior appropriators be protected. However, that protection does not extend to the point of denying junior appropriators use of water that is beyond the amount necessary to meet the rights of senior appropriators. So, how can the rights of senior surface water appropriators be protected from injury by junior ground water appropriators? I believe this protection can be provided through adequate management of the resource, which includes regulating water diversions and the implementation of mitigation plans.

Adequate management requires knowledge of the resource and collaborative efforts between resource users and resource managers. In terms of knowledge, the Upper Snake River Basin Study described in this report provides a much improved level of knowledge compared with what existed prior to the study. However, even though all of the study elements of the study plan developed for the Upper Snake River Basin Study were completed, "gaps" exist between the knowledge gained from the study and the level of knowledge needed to formulate appropriate mitigation plans. For example, one of the conclusions from the study concerning recharge is that even if all existing canal facilities are used to convey water for recharge when available, the amount of recharge will not be sufficient to restore ground water levels and spring discharges to desirable levels. The study plan did not include a task to evaluate any potential recharge sites that could be developed with new conveyance facilities that could more closely achieve desirable ground water levels and spring discharges. Consequently, this task remains to be completed.

Another area not fully addressed by the plan of study completed by the Upper Snake River Basin Study is the question of injury to holders of senior surface water rights from ground water diversions under rights having junior priorities. One of the principal elements of the study was the estimation of the effects from ground water uses on water availability to the North Side and Twin Falls Canal Companies. This was accomplished by taking the estimated effects of ground water withdrawals on gains to the Snake River and inputting those effects into the accounting system used by Water District 1 to account for use of natural river flow and storage water. This approach provided an estimate of the magnitude of the impact from junior priority ground water diversions on water availability for senior priority surface water uses under the current conditions of the hydrologic regime, but was not an assessment of injury. It is well known that the hydrologic regime of the Eastern Snake Plain Aquifer has been enhanced by the widespread irrigation of lands above the aquifer. Whether or not impacts to a particular senior appropriator in a hydrologic regime enhanced by the historic water use of other appropriators fully constitutes injury is an issue that needs to be considered. Any diversion of water from either a ground water source or a surface water source can impact other diverters, but such impacts do not always constitute injury. Regardless of the extent that estimated impacts constitute injury, the Upper Snake River Basin Study did not include a study element to provide a basis for distributing the impacts to specific zonal groupings of wells.

Given these and other "gaps" between the knowledge gained from the Upper Snake River Basin Study and the level of knowledge needed to formulate appropriate mitigation plans, additional studies of the interaction between ground water and surface water, and the effects of ground water withdrawals and recharge, need to be performed. Perhaps some believe that the $287,000 expended to perform the Upper Snake River Basin Study should have been sufficient. Others might believe that the "gaps" cannot be closed without the development of a real-time decision support system for the Snake River Basin. The development of a real-time decision support system similar to that which will probably be developed eventually for the Snake River Basin is well under way for the Colorado River Basin at a cost thus far in excess of $5,000,000 and an expenditure of at least another $3,000,000 anticipated. While development of a decision support system for the Snake River Basin would clearly benefit the resolution of conflict over water use, complete development of such a system in the immediate future is not feasible. In particular, the time required to develop a real-time decision support system for the Snake River Basin is not compatible with the urgency of providing an improved basis for planning mitigation. Nonetheless, analytical evaluations beyond those performed during the $287,000 study effort funded thus far need to be accomplished.

Specifically, the following 10 additional study tasks need to be completed:

1. The input data from the existing two-dimensional model need to be transferred to an appropriate three-dimensional model and studies conducted to evaluate how sensitive analytically

predicted results are to three-dimensional effects. Although the data do not exist to fully describe the hydrogeologic characteristics of the Eastern Snake Plain Aquifer in three dimensions, it is important to determine whether three-dimensional effects could be significant in estimating the effects of ground water withdrawals and recharge.

2. Beginning with the existing model, estimates of the effects of aggregated ground water withdrawals within geographic units having appropriate zonal boundaries need to be made. This will begin to allow delineation of which groupings of wells have the greatest effect on specific senior surface water appropriators.

3. Defined objectives need to be established to provide focus for future recharge efforts and to provide a basis for measuring the effectiveness of managed recharge. While the following objectives may not be exclusive, meeting these objectives should provide meaningful improvement in the availability of water to fill existing water rights for the use of both surface and ground waters: (a) increase spring flows tributary to American Falls Reservoir; (b) increase spring flows discharging to the Thousand Springs reach of the Snake River; (c) stabilize ground water levels in the Jefferson County region; (d) stabilize ground water levels under the A & B Irrigation District; and (e) stabilize ground water levels under that portion of the Southwest Irrigation District over the Eastern Snake Plain Aquifer.

4. Identify alternative sites and prepare preliminary designs for infiltration basins that could provide for recharge that would meet the objectives defined above, or others that may be added or substituted, and would provide recharge capacity (individually or collectively) on the order of 500,000 acre-feet annually, assuming water would be available without injuring existing water rights, including those for minimum stream flows, at least during some years.

5. Develop preliminary designs for diversion and conveyance facilities that could divert and transport water from the Snake River and its tributaries to the alternative recharge sites which would meet the defined objectives.

6. Prepare preliminary cost estimates for constructing alternative recharge projects that would meet the defined objectives.

7. Conduct preliminary environmental investigations for the alternative recharge projects to identify potential environmental enhancements or detrimental effects to other environmental resources, such as water quality.

8. Identify the most feasible alternatives for managed recharge based on capability for meeting defined objectives, costs, and environmental effects.

9. Develop a method for accounting for water contributed by Idaho through managed recharge towards flow augmentation for salmon migration and habitat enhancements for other threatened or endangered species.

10. Determine the most appropriate process for authorizing recharge under existing or new water rights, including who holds the water rights and how benefits are determined and credited.

The primary goal of this additional study and evaluation is to identify which groups of junior ground water appropriators are potentially responsible for mitigating injury to particular senior surface water appropriators. The secondary goal is to identify which alternative projects for managed recharge would be most effective and feasible for mitigating injury. To the extent injury is established or agreed upon, junior ground water appropriators would be expected to implement the identified projects for managed recharge at their own cost through established ground water districts, new ground water districts, or through other appropriate means.

In some instances, for example situations involving injury to senior appropriators such as the North Side and Twin Falls Canal Companies who rely on spring flows tributary to American Falls Reservoir, it will be more effective for junior ground water appropriators to provide mitigation water directly to American Falls Reservoir, or other reservoirs, than to use water available for mitigation in a recharge project. While some recharge will still likely be necessary (see following discussion of mitigation wells), providing mitigation water for delivery directly out of existing reservoirs would provide direct compensation to the senior water right holders injured by reduced tributary spring flows. When available, mitigation water could be provided by leasing water from the water bank. In some instances, storage water leased from the water bank as mitigation for injury to senior rights for direct or natural flow could have been placed in the water bank by those same senior appropriators. In such cases, the senior appropriators benefit from using storage water leased by junior ground water appropriators from the water bank in lieu of storage water not placed in the water bank because the latter can be carried over for use during future drought periods and compensation has been made by the junior appropriators for the storage water provided through the water bank.

Eventually, there will be dry-year sequences during which: (a) direct or natural flows in the Snake River are not sufficient to fill the rights of senior appropriators; (b) those senior appropriators do not have sufficient storage water to provide for their necessary water supply; and (c) water is not available for lease from the water bank. During such dry-year sequences, it would not be consistent with the prior appropriation doctrine and Idaho's constitution and statutes for junior appropriators of ground water from an unconfined aquifer to have a full water supply while the water rights for senior surface water appropriators which rely on discharges to the river from the same unconfined aquifer could not be met. Hypothetically, mitigation during such a dry-year sequence could be offered to the senior appropriators for irrigation uses in the form of cash payments for loss of crops, reduction in crop yields, or even dry-year fallowing. Since the senior appropriator is not bound to mitigation in the form of cash payments, an alternative form of mitigation could be to fallow previously agreed upon acreage under ground water irrigation, and the ground water that would have been supplied to the fallowed acreage could be pumped to supply mitigation water to the senior appropriator (mitigation wells). Some might question the concept of depleting a reduced supply of ground water, as measured by decreased spring discharges, to provide mitigation for injury to surface water supplies already reduced by diminished spring flows. However, these depletions could be countered over the long term through managed recharge. Obviously, there are numerous issues, such as how water would be delivered from mitigation wells for use by senior appropriators, that require further consideration before this approach could be viewed as feasible. Nonetheless, this concept for mitigation is consistent with the prior appropriation doctrine and Idaho laws.

All of the preceding require knowledge of the water resources of the Upper Snake River Basin and the interaction between ground waters and surface waters. Perhaps even more important to the successful conjunctive management of these resources is productive collaboration between all the users that rely on the continued viability of the surface and ground water resources and with the managers of these publicly-owned resources. For the junior appropriators, it is important that they respect the rights of the senior appropriators. For the senior appropriators, it is important they respect the constitutional provisions which allow for optimal use of these resources which are the property of the state. For the managers of these resources, we must continue to develop innovative ways to manage and resolve conflicts between legal uses in accordance with the rights and priorities granted for those uses.